EXPERIMENT 16: THE INVERSE-SQUARE LAW

material: incandescent light bulb (40W or 60W), light meter or lux meter(0-50,000 or 0-100,000 Lux) meter, meter stick, ruler

applet to try:

http://hypnagogic.net/sim/Sim/1overR2/1overR2.html

to watch:
https://www.youtube.com/watch?v=JW3tT0L2gpc

DATE_____

AUTHOR_____

PARTNER_____

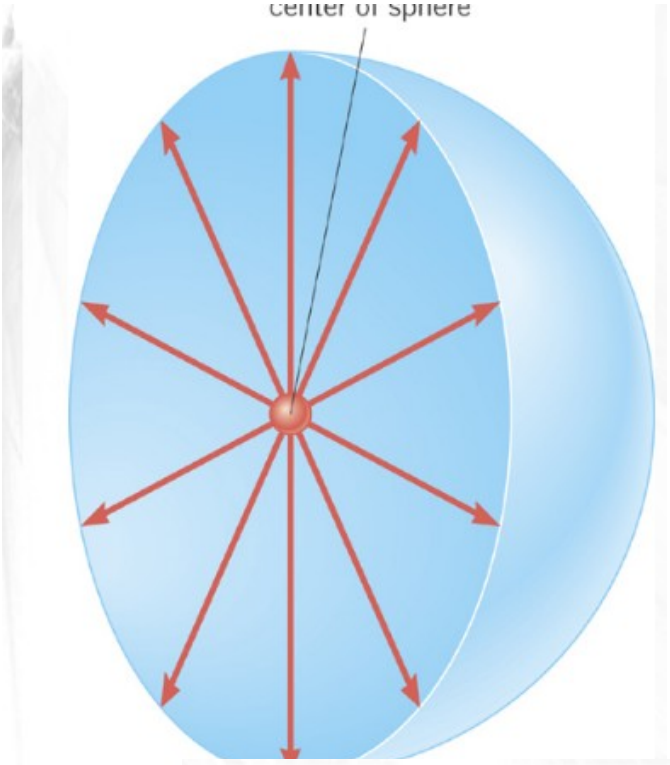
PARTNER_____

BACKGROUND

The inverse-square law relates the apparent brightness b, of a star, with its luminosity L :

$$b = \frac{L}{4\pi d^2}$$

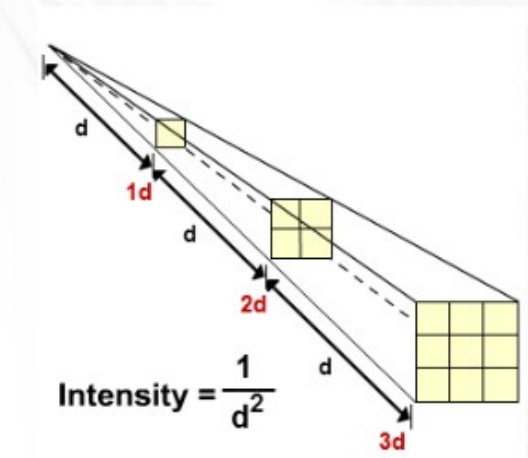
The **luminosity L** is the **power** of the star = **how much energy is produced per second**. The unit is the Watt (W). b is the apparent **brightness** of the star at a distance d (m). The unit is watts per square meters (W/m^2). The apparent brightness b drops off as the inverse-square of the distance to the star.

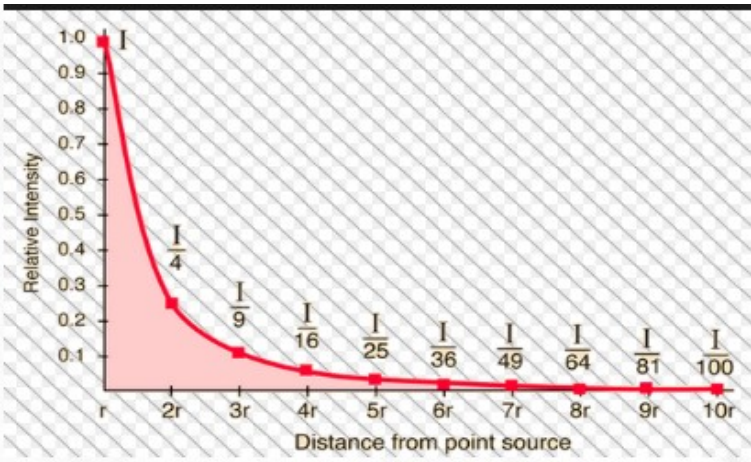


The total amount of energy L (luminosity or intrinsic brightness) flowing through the sphere per second is constant but the energy per unit area b per second (apparent brightness) decreases with distance d by the same amount factor that the area increases.

The red arrow is the distance d between the star and a detector. THIS IS THE INVERSE SQUARE LAW

SAME LAW APPLIES TO :
GRAVITY, ELECTRIC FIELD, RADIATION, SOUND ..





If we assume that our light source in this experiment is a point source, we should be able to investigate the validity of the inverse-square law, and determine the luminosity of the light source.

This detector will not use the unit watts/m^2 but foot-candles (also energy per unit area) which is a similar unit but not a SI unit.

PROCEDURE

Take measurements of light intensity in foot-candles, using the light meter **set at range A**, at the positions indicated in the table below. Be careful to measure all distances from the "center of the source". Record the measurements in the table below, column 2.

Distance d (m)	Intensity b (foot-candles)	Inverse-square distance $1/d^2$ (m^{-2})
0.15 (so 15cm)		44.4
0.18 (18cm)		31
0.20 (or 20cm)		25.00
0.22 (or 22cm)		20.7
0.24 (or 24cm)		17.4
0.26 (26cm)		14.8
0.28 (28cm)		12.8
0.30 ...		11.
0.34		8.7
0.38		7
0.45		5
0.50		4
0.52		3.7
0.55		3.3
0.60		2.8
0.65		2.34

ANALYSIS – <u>Don't put the materials away but switch off the bulb.</u>

1) With a spreadsheet (LibreOffice)
Make a scatter graph : *intensity (b) versus distance (d).* Then connect the dots with a line (smooth).
X-axis = distance d and Y-axis = intensity b
So with a spreadsheet the first column is the x-axis and the second column is the y-axis.
Give the graph a title and label the axis. DO NOT try to fit a trend line. THIS IS A CURVE NOT A LINE.
Save the graph and staple it to your lab report. (you can screenshot the graph or you can use the snipping tool to copy the graph and save it in a document).

2) Do you get an inverse square law ? To find out go on line on https://www.wolframalpha.com/ and type in the field:: **plot 1/x**2 for x between 0 and 10**

Do you get a graph similar to yours ? Copy and paste the graph you get (using screen shot or snipping tool) in a document to print it at home. Staple to your lab report.

3) Use your first graph (experiment) to predict the intensity of the light at a distance of 40cm from the source (or .40m) b = _____. This is your experimental value.

GO BACK TO YOUR EXPERIMENT

Now use your sensor and place it at 40 cm from the source to record b = _____.
this is your accepted value. Compute the % error = _____
((accepted – experimental) / accepted) x100

4) watch the video: https://www.youtube.com/watch?v=JW3tT0L2gpc and answer the questions.
(don't ask me for help. You can figure it out ! It has to do with the inverse square law)
The french toast is at a distance 30cm from the butter gun. The toast is covered with butter but the layer is way too thick. You move the target at a distance 60cm from the gun.
How many french toasts you can cover now ? _____
The layer of butter on each toast is then thicker ? thinner ?
In that case, the layer on each toast is divided by: A) 2,B) 3 C) 4 d) 6

If the distance is now 90cm between the gun and the target. How many french toasts to you need to use all the butter sprayed ? _____. The layer on each toast is divided by _____

At the end of the video, the author explains that the inverse square law applies to :
_____ , _____ , _____ , _____

5) Suppose $y = 10/x^2$. If x1 = 1 then y1 = _____ (plug x) if x2 = 2 then y2 _____
So x2/x1= _____ y2/y1= _____ Is it consistent with what you have learnt in this lab ? why

CONCLUSION What was the goal of this lab ? Did you reach the goal of the lab ?